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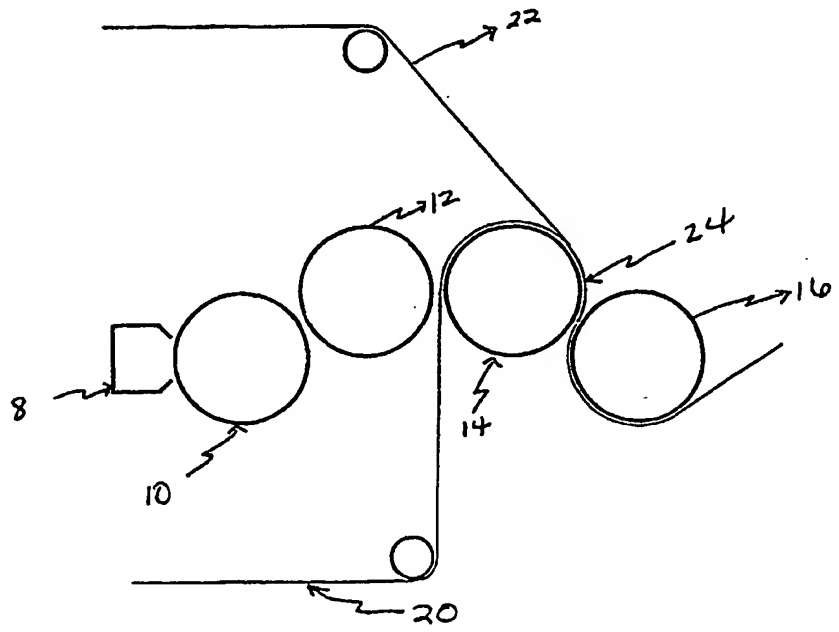
(54) Title: MULTIPLE SUBSTRATE PLY ATTACHMENT UTILIZING A FLEXOGRAPHIC PRINTING PROCESS TO APPLY CHEMICAL ADHESIVES ONTO TISSUE



(57) Abstract: The process of the present invention utilizes a flexographic magnetic printing roll (12) that is capable of applying either an ink, adhesive, and water mixture or an adhesive and water mixture onto a tissue (20) between the plies for ply attachment and artwork application. Thus, two or more ply tissues and towels made according to the present invention are printed with artwork and treated with an adhesive solution during one flexographic printing process.

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MULTIPLE SUBSTRATE PLY ATTACHMENT UTILIZING A FLEXOGRAPHIC PRINTING PROCESS TO APPLY CHEMICAL ADHESIVES ONTO TISSUE

Field of the Invention

The present invention is directed to a process for attaching two or more artwork-printed plies together through the use of an adhesive.

Background of the Invention

In the past, most of the multiple-ply tissue products known in the art have been flawed in that the multiple plies of tissue are often inadequately bonded together and the two plies frequently become unattached on the roll as it is being used. This results in the potential for the user to tear off a tissue sheet and utilize the reverse or back side. When tissue plies are reversed, the consumer inadvertently uses the harsh, rough, and scratchy side of the tissue rather than the soft and smooth side, thus causing consumer dissatisfaction.

In order to improve the quality of multiple-ply tissue products as it relates to ply reversal, improved ply attachment processes are needed. Such an attachment process optimally has a low operational cost, a low capital cost, and a minimal negative impact on the product.

Typically, when two or more artwork-printed plies of tissue are being attached together by adhesive glue, two completely separate processes are necessary. One process is needed to mechanically apply the printed ink artwork design to the tissue while a second process is necessary to apply an adhesive to the tissue. The use of two separate processes results in increased production costs and maintenance costs as well as increased machine clean-up time.

U.S. Patent No. 3,414,459 to Wells, for example, employs the steps of separately embossing each of two paper sheets and then adhesively joining them to form a laminated paper structure. Similarly, U.S. Pat. No. 5,858,554 to Neal et al. is directed to a multi-ply paper product wherein the plies are joined together through the use of an aqueous adhesive composition. The specification of this

patent reveals that the plies are embossed, but such embossing takes place after the plies are formed but before the adhesive composition is applied to one or both plies.

Likewise, U.S. Pat. No. 5,874,157 to Robinson et al. discloses a laminated paper product comprising a plurality of laminae that are joined with a laminating adhesive. The laminae may have interlocking embossments or embossed sites; however, the embossing of the laminae occurs prior to the joining process involving the laminating adhesive. Comparably, WO 98/50482 to Nunes et al. is directed to an adhesive composition for laminating an absorbent paper product and a method for making the same. This patent also claims the paper product wherein embossed plies are laminated using this adhesive composition. However, the plies are already embossed prior to being treated with the adhesive composition. Thus, these patents illustrate how the two processes of imprinting an artwork design onto a tissue and applying an adhesive to the same tissue are traditionally separate processes.

Methods other than those employing an adhesive solution are known in the art for bonding plies of tissue laminae together to form a single laminate. For example, U.S. Pat. Nos. 4,806,418 and 4,867,831 to Sigl, both assigned to the assignee of the present invention, provide for ply attachment through the distribution of thermoplastic particles between the plies and the subsequent melting of these particles to bond together the fibers of the plies.

Furthermore, U.S. Pat. No. 5,143,776 to Givens is directed to a laminate of two tissue laminae adhesively joined by hot melt adhesive. In this patent, the hot melt adhesive forms the pattern of a single longitudinally or transversely oriented stripe. The patent states that the stripe of adhesive is interposed between the laminae, but it does not suggest that the application of this hot melt adhesive could simultaneously involve the printing of an artwork design.

Also, U.S. Pat. No. 4,816,320 to St. Cyr describes a process

wherein the outer surface of one tissue layer is dotted or stippled with fine dots or atomized droplets of adhesive material mist-sprayed thereon. The multiple plies are then bonded together to form integral improved tissue sheets. Thus, the methods described for joining multiple plies of tissue together to form a tissue laminate do not contemplate the combination of a process for applying an adhesive solution with a process for imparting a printed artwork design to the same tissue plies.

Flexographic processes have been used frequently in the printing industry, and such flexographic printing processes have proven to have a negligible impact on increasing tissue ply stiffness.

Various products are known in the art that may be used as flexographic and/or magnetic printing plate assemblies. A European patent, EP 0058737/A1, discloses a photosensitive flexographic element. The flexographic element in this reference comprises a layer of a photosensitive, elastomeric composition attached to a flexible support. This element is useful in the preparation of flexographic printing plates.

Similarly, U.S. Pat. No. 3,670,646 to Welch, Jr. is directed to a flexible printing plate-saddle assembly into which magnetic particles are incorporated in order to provide an improved means for securing the printing plate to a printing press. Also, U.S. Patent No. 3,824,927 to Pugh et al. provides for a printing member in which the printing element is held in position on a conventional roll by magnetic means. Such printing assemblies are useful in printing an artwork design onto a tissue laminate; however, they do not provide any means for simultaneously applying an adhesive solution to tissue plies.

Therefore, a need currently exists for a single, more efficient process that combines the application of a printed ink artwork design to a tissue with the application of an adhesive to a tissue.

Summary and Objects of the Invention

It is an object of the present invention to combine the process

of applying a printed ink artwork design to a tissue and the process of applying an adhesive to a tissue into a single, more efficient process.

This and perhaps other objects of the present invention are accomplished through the use of a flexographic magnetic printing roll that applies either an ink, adhesive, and water mixture or an adhesive and water mixture onto tissue between the plies for the purpose of ply attachment and/or artwork application. In certain embodiments of the present invention, the flexographic magnetic printing roll is in the shape of a desired artwork and uses the artwork design to apply the chemical mixture of adhesive to the tissue.

In contrast to the above-described processes and products, the process of the present invention does not involve a flexographic element coated with the elastomeric composition described in EP 0058737/A1. The invention contemplated herein, in fact, goes beyond the creation of either a new flexographic element or a new printing plate assembly and seeks to combine two traditionally separate processes (the application of a printed artwork design to a tissue and the application of an adhesive to that tissue) into a single, more efficient process. The patent references described above do not contemplate such a combination of two separate processes with the use of one flexographic printing roll.

In certain embodiments of this process, the chemical mixture is 1 part water, 1 part adhesive, and 0.0302 parts full concentrated ink. In other embodiments, a mixture of only adhesive and water containing 1 part adhesive and 1 part water is used. These and other features, aspects and advantages of the present invention will become better understood with reference to the following description and appended claims.

Brief Description of the Drawings

FIG. 1 shows a schematic diagram of the flexographic printing process described herein.

FIG. 2 shows the orchid print pattern used in the flexographic

process described here.

FIG. 3 shows a dotted print pattern with a low print area used in the process of the present invention.

FIG. 4 shows a dotted print pattern with medium print area used in the process of the present invention.

Detailed Description of Representative Embodiments

Reference now will be made in detail to the embodiments of the invention, one or more examples of which are set forth below. Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that various modifications and variations can be made in the present invention without departing from the scope or spirit of the invention. For instance, features illustrated or described as part of one embodiment, can be used on another embodiment to yield a still further embodiment.

Thus, it is intended that the present invention cover such modifications and variations as come within the scope of the appended claims and their equivalents. Other objects, features and aspects of the present invention are disclosed in or are obvious from the following detailed description. It is to be understood by one of ordinary skill in the art that the present discussion is a description of exemplary embodiments only, and is not intended as limiting the broader aspects of the present invention, which broader aspects are embodied in the exemplary constructions.

The process of the present invention attaches two-ply bath tissue together using a flexographic magnetic printing roll to apply either an ink, adhesive, and water mixture or an adhesive and water mixture onto tissue between the sheets for the purpose of ply attachment with or without simultaneous artwork application. This flexographic magnetic printing roll provides the desired artwork and utilizes its artwork design capabilities to apply this chemical mixture to the tissue. Thus, the process combines two manufacturing processes

into a more efficient process. This combination of two processes into one results in increased efficiency because production and maintenance costs are reduced. Also, machine clean-up time is reduced through this combination.

Various tissue-making processes are known to those in the art. In particular, U.S. Patent No. 5,129,988 to Farrington, Jr. and U.S. Patent No. 5,494,554 to Edwards et al. disclose various tissue-making methods and processes for forming multi-layered paper webs. Such patents are incorporated herein in their entireties by reference thereto. These tissue-making processes and the tissue products resulting thereby may be utilized in the process of the present invention for forming the plies of tissue that are then printed with artwork and joined together by the flexographic printing roll described herein.

Furthermore, processes for forming uncreped through-air dried webs are described in U.S. Patent Nos. 5,779,860 to Hollenberg et al. and 5,048,589 to Cook et al., both of which are assigned to the assignee of the present invention and both of which are incorporated herein in their entireties by reference thereto. In such processes, through-air drying is employed as shown in the Figures of Cook et al. As described and shown therein, a web is prepared by: (1) forming a furnish of cellulosic fibers, water, and a chemical debonder; (2) depositing the furnish on a traveling foraminous belt, thereby forming a fibrous web on top of the traveling foraminous belt; (3) subjecting the fibrous web to noncompressive drying to remove the water from the fibrous web; and (4) removing the dried fibrous web from the traveling foraminous belt. The process described therein does not include creping and is, thus, referred to as an uncreped through-air drying process.

Tissue products prepared from this uncreped through-air drying process will typically possess relatively high levels of absorbent capacity, absorbent rate and strength. In addition, because the process avoids the use of costly creping steps, tissue products

formed according to such a process will generally be more economical to produce than creped towels of similar composition and basis weight.

A process that produces a noncompressed sheet using can drying which may be employed in the present invention is described in U.S. Patent No. 5,336,373 to Scattolino et al., which is incorporated herein in its entirety by reference thereto.

Embodiments of the present invention are represented by the process diagramed in FIG. 1. In such embodiments, ply attachment using an ink, adhesive, and water mixture may be achieved by mixing 1 part water with 1 part adhesive and 0.0302 parts full concentrate ink to yield the final chemical solution. This adhesive solution is pumped into a reservoir or doctor chamber 8 and then applied onto antilox roll 10 by doctor chamber 8 using two doctor blades that keep the doctor chamber 8 sealed. Antilox roll 10 functions similarly to a gravure roll except that antilox roll 10 is more durable and has a much longer production life in commercial applications. Antilox roll 10, used in certain embodiments of the present invention, is made by placing a coating (approximately 0.020 inches thick in some cases) of chromium oxide on the outer perimeter of a round steel roll. The chromium oxide may then be etched with a laser. The laser burns microscopic "pot-holes" called gravure cells onto the surface of the chromium oxide.

Thus, these microscopic pores along antilox roll 10 fill up with the above-described mixture of ink, adhesive, and water as roll 10 is rotated about its centerline. The adhesive solution is then mechanically transferred onto flexographic printing roll 12. The now-filled gravure cells or microscopic pores are rotated around until they contact rubber flexographic printing roll 12. A specific metered amount of the chemical mixture is then transferred, due to capillary forces, out of the gravure cells on antilox roll 10 and onto flexographic rubber roll 12.

This printing roll 12 has an engraved raised artwork pattern on its surface, and it contacts the inside of first sheet 20 of two tissue sheets and applies or prints the mixture onto first sheet 20. This first sheet 20, now containing the mixture of ink, adhesive, and water on its surface, is then met by untreated tissue sheet 22, and the two sheets 20 and 22 are "married" together by the backing roll or marrying roll 14. The two-ply sheet 24 then passes over another rubber roll 16 and may be further converted in additional processes.

Thus, the present invention produces a tissue product wherein the ink, adhesive, and water mixture is between the layers and not on the exterior as in known products.

In alternative embodiments of the present invention, the above-described process is performed with a mixture of only adhesive and water, containing, for example, 1 part adhesive and 1 part water.

In certain embodiments of the present invention, a towel may be the substrate rather than a tissue. The towel is likewise able to undergo the above-described flexographic printing process.

In one embodiment of the present invention, the engraved raised artwork design located on the flexographic roll includes floral designs such as orchid shapes, which apply the chemical mixture of either ink, adhesive, and water or adhesive and water to the tissue or towel.

Examples

The present invention may be understood by reference to the following Examples, without being limited thereto. Two experimental trial runs were performed in accordance with the present invention. These two experiments investigated the feasibility of obtaining ply attachment for a two-ply uncreped through-air dried bath tissue using the flexographic gluing process described herein. Both the effectiveness of the adhesive process and the effects on the tissue products' quality were studied. In both Examples, the process of the present invention was performed on the bath tissue at a speed of 350

feet per minute, and pilot plant scale equipment was used during these experiments.

Specific descriptions of the trial runs and the results of each Example are fully described below. Generally, the experiments described in these examples showed successful ply attachment at converting speeds of 350 feet per minute. Also, the quality of the tissue products formed according to the present invention proved to be comparable to the quality of tissue products laminated together by other ply attachment methods such as the use of a crimping wheel.

Example 1

During this Example, the adhesive used was product number 48037 made by Reichold Chemicals, Inc. in Durham, NC. This adhesive is a cornstarch- based adhesive with a viscosity of approximately 70cp. Although this particular adhesive was utilized in the examples, any adhesive such as cellulose-based, polyvinyl-based, etc. could be employed. In addition, adhesives having a viscosity of from about 20 to about 200 centipoises would generally meet the requirements of an adhesive sufficient to bond the The final glue or adhesive that was applied to the sheet during this Example was a 50 percent by volume glue and 50 percent by volume water mixture.

During this experimental trial, ink was added to the glue and water mixture. The ink used herein was a dark charcoal grey water-based ink (product number 430-Z-4, color code "Butterfly Grey") made by Daw A J Printing Co. in Appleton, WI. However, alternative water-based inks of any color and any concentration level may be used in the process of the present invention. The ink was mixed with the glue and water in the following manner: 1.75 gallons of the Reichold 48037 adhesive, 1.75 gallons of water, and 200 mL of the grey ink. All of the chemicals used were 100% water-soluble.

A flexographic gluing process was performed. The converting equipment used in this experiment was set up in the following order:

first unwind, second unwind, large roll calendar, coater (modified to become a flexographic printer), small roll calendar, and rewinder. The converting speed was 350 feet per minute using two-ply uncreped through-air dried bath tissue with a total weight of 20 lbs./2880 ft^2. The process was performed in order to laminate two plies of bath tissue together using the above-described water-soluble, starch based adhesive.

The process settings for this Example are described below in Table I:

Table I

Low Print Area	0.0048 in^2 print area per 1 in^2 of tissue
High Print Area	0.0276 in^2 print area per 1 in^2 of tissue
Machine Speed	350 feet/minute
Bath Tissue Basesheet	Uncreped through-air dried tissue sheet
Bath Tissue Weight per Ply	10 lbs./2880 ft^2
Adhesive Used	Reichold 48037, Diluted to 50 volume % water, Viscosity 70 cp
Nip Width between Antilox Roll and Flexographic Printing Roll	13 mm of interference
Nip Width between Flexographic Printing Roll and Steel Marrying Roll	9 mm of interference
Nip Width between Steel Marrying and Urethrane Backing Roll	9 mm of interference
Glue Add-on Onto Sheet	5 weight % solids

The flexographic print pattern used during this experiment was an orchid pattern, shown in Figure 2. This orchid pattern results in a high adhesive add-on relative to the tissue sheets because the pattern has a high contact area. Thus, an optimal balance between liquid glue solids concentration and print area was achieved as print area increased, glue solids concentration decreased and vice versa. It was found in the experiments done according to Example 1 that

glue add-on of 5 weight percent solids in conjunction with the orchid print pattern produced sufficient ply attachment.

The test method used for determining the success of the ply attachment was Standard Test Method 814-W in which a Slip/Peel tester (manufactured by Instrumentors, Inc.) was used. The peel tester was used in the peak load setting.

In general, the results of the experiments run in accordance with Example 1 resulted in high quality ply attachment at a machine speed of 350 feet per minute. Also, the overall product quality of the resulting two-ply tissue product produced by the flexographic gluing process was comparable to the product quality of tissue products produced using prior art control processes. For example, tissue products formed according to the flexographic process of the present invention had similar softness, stiffness, and drapeability as tissue products in which ply attachment was facilitated by a crimping wheel. Furthermore, with the flexographic gluing process, it was found that absorbency, bulk, wet and dry strength, opacity, and brightness did not appear to differ significantly from other prototypes made without the flexographic process. Thus, the flexographic adhesive process did not negatively impact the overall products quality.

Tests were also conducted to compare the glued product produced according to the present invention with a non-glued prototype. Several softness tests (such as hand ranking and simulated use panel) showed that the prototypes formed according to the present invention demonstrated comparable characteristics.

Example 2

During this Example, the adhesive used was product number 18-1537 made by National Starch and Chemical Co. of Bridgewater, NJ. This adhesive is also cornstarch-based with a viscosity of approximately 70cp and is 100% water-soluble. The final glue or adhesive that was applied to the sheet during this experiment was a 70 percent by weight glue and 30 percent by weight water mixture.

No ink was incorporated into the mixture used herein.

The overall flexographic process used in Example 2 was identical to that used in Example 1 except the use of a different adhesive without the addition of an ink. The process settings for this experiment are set forth below in Table II:

Table II

Low Print Area	0.0048 in^2 print area per 1 in^2 of tissue
High Print Area	0.0276 in^2 print area per 1 in^2 of tissue
Machine Speed	350 feet/minute
Bath Tissue Basesheet	Uncreped through-air dried tissue sheet
Bath Tissue Weight per Ply	10 lbs./2880 ft^2
Adhesive Used	National Starch 18-1537, Diluted to 30 weight % water, Viscosity 60 cp
Nip Width between Antilox Roll and Flexographic Printing Roll	13 mm of interference
Nip Width between Flexographic Printing Roll and Steel Marrying Roll	9 mm of interference
Nip Width between Steel Marrying and Urethrane Backing Roll	9 mm of interference
Glue Add-on Onto Sheet	5 weight % solids

One of the flexographic print patterns used in this Example was the orchid print pattern, shown in Figure 2. It was determined during the process of this Example that the glue add-on level relative to the tissue sheet should approximate 5 weight percent solids to obtain acceptable ply attachment when using the orchid print pattern.

Attempts were made during the process of this Example to use two other flexographic printing plates with varying print areas. These other printing plates were used in order to minimize the glue add-on relative to the tissue sheets by reducing the contact area of the flexographic printing plates. A dotted print pattern with a low print

area (seen in Figure 3) and a dotted print pattern with a medium print area (seen in Figure 4) were used. The dots imprinted onto the tissue sheets in both Figs. 3 and 4 were 3/64 inches in diameter. The pattern with the low print area had dots spaced 1 inch apart in a 45 degree diamond pattern. The print pattern with the medium print area had dots spaced 1/2 inch apart also in a 45 degree diamond pattern.

These and other modifications and variations to the present invention may be practiced by those of ordinary skill in the art, without departing from the spirit and scope of the present invention, which is more particularly set forth in the appended claims. In addition, it should be understood that aspects of the various embodiments may be interchanged both in whole or in part. Furthermore, those of ordinary skill in the art will appreciate that the foregoing description is by way of example only, and is not intended to limit the invention so further described in such appended claims. Therefore, the spirit and scope of the appended claims should not be limited to the description of the preferred versions contained therein.

What is Claimed is:

1. A method for forming a tissue product having a printed design on at least one of its surfaces, said method comprising:

providing a first sheet of tissue;

providing a second sheet of tissue;

applying an adhesive mixture to one of said first or second tissue sheets with a flexographic printing roll having a raised design on its surface to imprint said design onto one of said tissue sheets; and

then compressing said first and said second tissue sheets together so as to form a multiple-ply tissue having said printed design thereon.

2. The method according to claim 1 wherein said adhesive mixture also comprises an ink.

3. The method according to claim 1 wherein said adhesive mixture comprises an adhesive and water in amounts sufficient to allow said tissue sheets to be formed into said multiple-ply tissue.

4. The method according to either claim 1 or claim 2 wherein said raised design is a floral design.

5. The method according to either claim 1 or claim 2 wherein said adhesive solution comprises an adhesive with a viscosity in the range of from about 20 to about 200 centipoises.

6. A multiple-ply tissue laminate that is bonded by a flexographic printing process wherein the inside of one ply of said laminate has been imprinted with a design and simultaneously treated with an adhesive mixture by a flexographic printing roll, said flexographic printing roll having said design on its surface, said design being a raised design.

7. A two-ply laminate according to claim 6 wherein said adhesive mixture comprises an adhesive and water in amounts sufficient to allow said plies to be formed into said multiple-ply laminate.

8. A two-ply laminate according to claim 6 wherein said adhesive mixture comprises an adhesive and an ink.

9. A two-ply laminate according to either claim 6 or claim 7 wherein said raised design is a floral design.

10. A two-ply laminate according to either claim 6 or claim 7 wherein said adhesive solution used to treat said one ply of said laminate comprises an adhesive with a viscosity of between about 20 cp and 200 cp.

11. A two-ply laminate according to either claim 6 or claim 7 wherein said laminate is a tissue product.

12. A two-ply laminate according to either claim 6 or claim 7 wherein said laminate is a towel.

13. A two-ply laminate according to either claim 6 or claim 7 wherein said laminate is a tissue product chosen from the group of bath tissue or facial tissue.

FIGURE 1

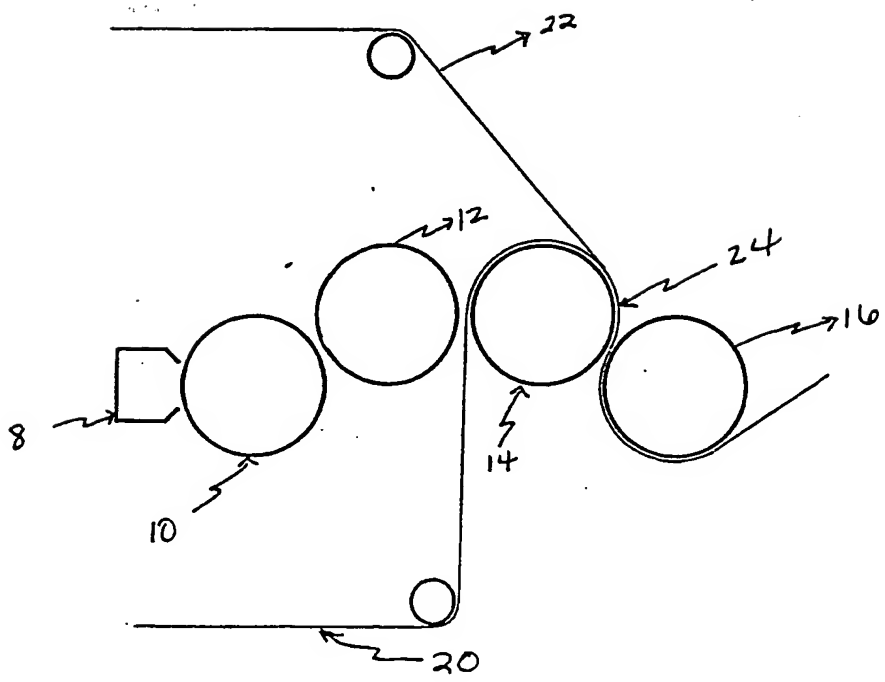


FIGURE 2

FIGURE 3

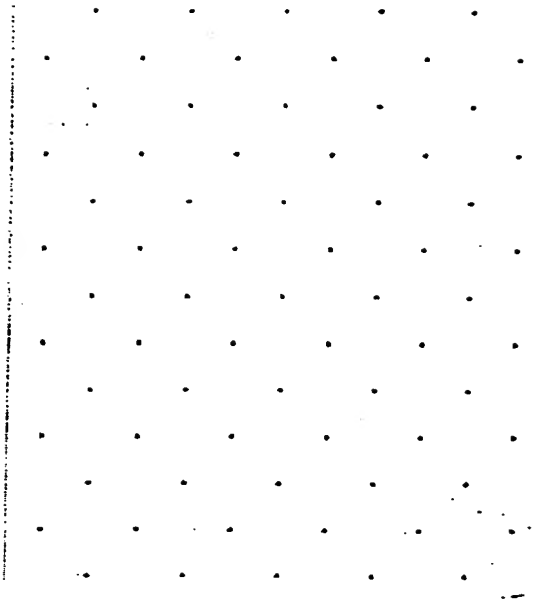
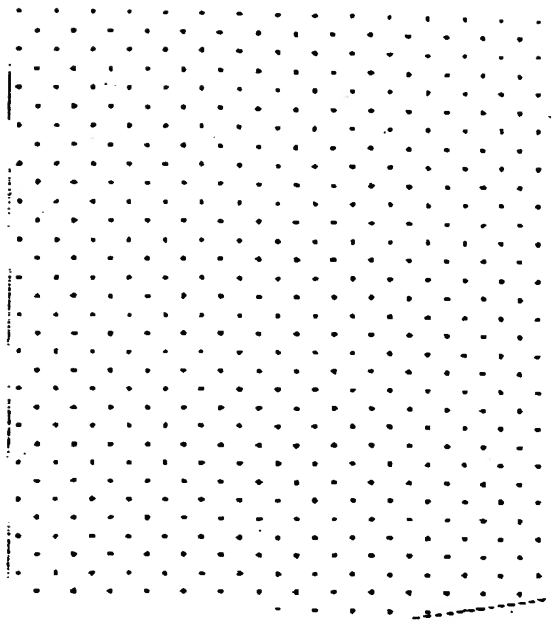


FIGURE 4



INTERNATIONAL SEARCH REPORT

Int. Ional Application No
PCT/US 00/34568

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B31F5/04 B31F1/07

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B31F B32B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 738 588 A (SCOTT PAPER CO) 23 October 1996 (1996-10-23) column 1, line 29 - line 34 column 5, line 25 -column 6, line 25 claim 19; figures	1-13
X	EP 0 776 758 A (JAMES RIVER) 4 June 1997 (1997-06-04) page 3, line 6 - line 7 page 3, line 40 - line 50 page 2, line 30 - line 42; figures	1,2,6,7
A	FR 2 075 452 A (INT PAPER CANADA) 8 October 1971 (1971-10-08) page 7, line 1 -page 8, line 6 figures	1,6

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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Date of the actual completion of the international search	Date of mailing of the international search report
27 March 2001	04/04/2001

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Lanaspeze, J

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Int. .ional Application No
PCT/US 00/34568

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication,where appropriate, of the relevant passages	Relevant to claim No.
A	US 3 867 225 A (NYSTRAND ERNST DANIEL) 18 February 1975 (1975-02-18) column 1, line 63 -column 2, line 21 figures	1,6
A	WO 92 14605 A (KAYSERSBERG SA) 3 September 1992 (1992-09-03) page 3, line 11 - line 32 page 4, line 28 -page 5, line 36 figures	1,4,6,9
A	WO 99 14035 A (PROCTER & GAMBLE) 25 March 1999 (1999-03-25) page 6, line 13 - line 17	1,6

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. ional Application No
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